

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

Product Name: Vehicle Mount Computer
Brand Name: Honeywell
Marketing Name: Thor VM3
Model No.: VM3WWANUS
Model Difference: N/A
FCC ID: HD5-VM3WWANA
Report No.: ER/2015/20026
Issue Date: Apr. 07, 2015
FCC Rule Part: §15.247, Cat: DTS
Prepared for:
Prepared by:
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Honeywell Scanning and Mobility
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VERIFICATION OF COMPLIANCE

Applicant: Honeywell International Inc.,
Honeywell Scanning and Mobility
9680 Old Bailes Road, Fort Mill, SC 29707, USA

Product Name: Vehicle Mount Computer

Brand Name: Honeywell

Marketing Name: Thor VM3

Model No.: VM3WWANUS

Model Difference: N/A

FCC ID: HD5-VM3WWANA

File Number: ER/2015/20026

Date of test: Feb. 04, 2015 ~ Apr. 07, 2015

Date of EUT Received: Feb. 04, 2015

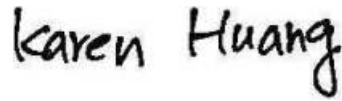
We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Electronics & Communication Laboratory. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.

The test results of this report relate only to the tested sample identified in this report.

Test By:**Date**

Apr. 07, 2015

*Marcus Tseng / Engineer***Prepared By:****Date**

Apr. 07, 2015

*Karen Huang / Clerk***Approved By:****Date**

Apr. 07, 2015

Jim Chang / Asst. Manager

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Revision History

Report Number	Revision	Description	Issue Date
ER/2015/20026	Rev.00	Initial creation of document	Apr. 07, 2015

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1 GENERAL INFORMATION

1.1 Product Description

General:

Product Name:	Vehicle Mount Computer
Brand Name:	Honeywell
Marketing Name:	Thor VM3
Model No.:	VM3WWANUS
Model Difference:	N/A
Product SW/HW version:	(a)Win7: 99.01.00.0002 (b)Win8: 99.01.00.0004 / ALXH48
Radio SW/HW version:	HCI version 6.8891 / LMP version 6.8891
Test SW Version:	CSR2.3
RF power setting in TEST SW:	N/A
Power Supply:	7.3Vdc form Rechargeable Li-ion Battery or 15Vdc from adapter
	Battery: Part No.:L3-52301624-R / OVT270L1R00 / 50121692-001, Supplier: TOTEX
	Adapter: Model No.:GT-81081-6015-T3 Supplier: GlobTek, Inc.

Bluetooth Low Energy:

Frequency Range:	2402 – 2480MHz
Bluetooth Version:	V4.0 dual mode
Channel number:	40 channels
Modulation type:	GFSK
Transmit Power:	1.14dBm (Peak)
Emission Designation:	1M03F1D
Antenna Designation:	Monopole chip Antenna, Gain: 0.5dBi Model No.: BT111, Supplier: Bluegiga Technologies

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1.2 Product Feature of Equipment Under Test

The equipment under Test (Hereafter Called: EUT) is Vehicle Mount Computer supporting, GSM / WCDMA / CDMA / LTE, Wi-Fi 802.11abgn, Bluetooth with GPS features, and below is details of information.

Product Feature	
Product Name:	Vehicle Mount Computer
Brand Name:	Honeywell
Marketing Name:	Thor VM3
Model No.:	VM3WWANUS
Model Difference:	N/A
FCC ID	HD5-VM3WWANA
GSM Operating Band(s)	GSM 850/1900MHz
GPRS / EGPRS Multi Slot Class	GPRS Class 10 / Class 12
CDMA / EVDO	BC0 / BC1 / BC10
WCDMA Operating Band(s)	FDD Band II / IV / V
WCDMA Rel. Version	Rel.8
LTE Operating Band(s)	FCC Band 2 / 4 / 5 / 13 / 17 / 25
LTE Rel. Version	Rel.9
Wi-Fi Specification	802.11a/b/g/n
Bluetooth Version	V4.0 dual mode

Note: The above EUT information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

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1.3 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 DTS Meas. Guidance V03r02

ANSI C63.10:2013

Note:

1. All test items have been performed and record as per the above standards.
2. The composite system is compliance with FCC Subpart B is authorized under the certification procedure.
3. The EUT was placed 1.5m height for frequency above 1GHz in accordance with ANSI C63.10:2013.

1.4 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan. (TAF code 0513)

FCC Registration Numbers are: 990257

Canada Registration Number: 4620A-4.

1.5 Special Accessories

There are no special accessories used while test was conducted.

1.6 Equipment Modifications

There was no modification incorporated into the EUT.

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2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is placed on a turn table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz,. The CISPR Quasi-Peak and Average detector mode is employed according to §15.107. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

2.3.2 Radiated Emissions

The EUT is placed on a turn table which is 0.8 m above ground plane. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.

2.4 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

Note:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Following shows an offset computation example with cable loss 2.1 dB.

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2.5 Configuration of Tested System

Fig. 2-1 Radiated Emission & Conducted (Antenna Port) Configuration

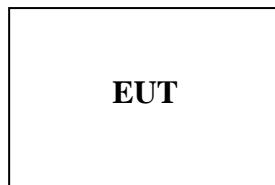


Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Bluetooth Test Software	CSR2.3	N/A	N/A	N/A	N/A

Fig. 2-2 AC Power Line Conducted Emission

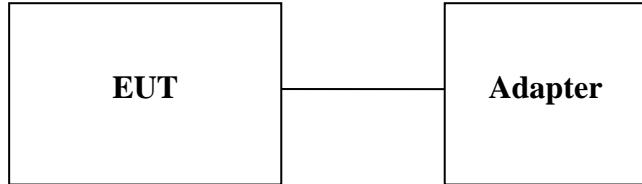


Table 2-2 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Bluetooth Test Software	CSR2.3	N/A	N/A	N/A	N/A

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3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	Compliant
§15.247(b) (3)	Peak Output Power	Compliant
§15.247(a)(2)	6dB Bandwidth & 99% Power Bandwidth	Compliant
§15.247(d)	Conducted Band Edge and Spurious Emission	Compliant
§15.247(d)	Radiated Band Edge and Spurious Emission	Compliant
§15.247(e)	Peak Power Density	Compliant
§15.203 §15.247(b)	Antenna Requirement	Compliant

4 DESCRIPTION OF TEST MODES

4.1 Operated in 2400 ~ 2483.5MHz Band

40 channels are provided for Bluetooth LE

CHANNEL	FREQUENCY	CHANNEL	FREQUENCY	CHANNEL	FREQUENCY
0	2402 MHz	14	2430 MHz	28	2458 MHz
1	2404 MHz	15	2432 MHz	29	2460 MHz
2	2406 MHz	16	2434 MHz	30	2462 MHz
3	2408 MHz	17	2436 MHz	31	2464 MHz
4	2410 MHz	18	2438 MHz	32	2466 MHz
5	2412 MHz	19	2440 MHz	33	2468 MHz
6	2414 MHz	20	2442 MHz	34	2470 MHz
7	2416MHz	21	2444 MHz	35	2472 MHz
8	2418 MHz	22	2446 MHz	36	2474 MHz
9	2420 MHz	23	2448 MHz	37	2476 MHz
10	2422 MHz	24	2450 MHz	38	2478 MHz
11	2424 MHz	25	2452 MHz	39	2480 MHz
12	2426 MHz	26	2454 MHz		
13	2428 MHz	27	2456 MHz		

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4.2 The Worst Test Modes and Channel Details

1. The EUT has been tested under operating condition.
2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

RADIATED EMISSION TEST:

RADIATED EMISSION TEST (BELOW 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
Bluetooth LE	0 to 39	0,20,39	GFSK	1.0	MAIN
RADIATED EMISSION TEST (ABOVE 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
Bluetooth LE	0 to 39	0,20,39	GFSK	1.0	MAIN

Note:

The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for Bluetooth LE 4.1 Transmitter for channel Low, Mid and High, the worst case E1 position was reported.

ANTENNA PORT CONDUCTED MEASUREMENT:

CONDUCTED TEST					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
Bluetooth LE	0 to 39	0,20,39	GFSK	1.0	MAIN

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5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.586 dB
Peak Output Power	+/- 0.84 dB
6dB Bandwidth	+/- 51.33 Hz
100 KHz Bandwidth Of Frequency Band Edges	+/- 1.55 dB
Peak Power Density	+/- 1.3 dB
Temperature	+/- 0.65 °C
Humidity	+/- 4.6 %
DC / AC Power Source	DC= +/- 0.13%, AC= +/- 0.2%

Radiated Spurious Emission:

Measurement uncertainty (Polarization : Vertical)	30MHz - 180MHz: +/- 3.37dB
	180MHz -417MHz: +/- 3.19dB
	0.417GHz-1GHz: +/- 3.19dB
	1GHz - 18GHz: +/- 4.04dB
	18GHz - 40GHz: +/- 4.04dB

Measurement uncertainty (Polarization : Horizontal)	30MHz - 167MHz: +/- 4.22dB
	167MHz -500MHz: +/- 3.44dB
	0.5GHz-1GHz: +/- 3.39dB
	1GHz - 18GHz: +/- 4.08dB
	18GHz - 40GHz: +/- 4.08dB

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

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6 CONDUCTED EMISSION TEST

6.1 Standard Applicable:

Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits dB(uV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Note

- 1.The lower limit shall apply at the transition frequencies
- 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

6.2 Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESCI7	100760	05/26/2014	05/25/2015
LISN	Rolf-Heine	NNB-2/16Z	99012	03/26/2014	03/25/2015
LISN	FCC	FCC-LISN-50/250-25-2-01	04034	03/19/2014	03/18/2015
Coaxial Cables	N/A	WK CE Cable	N/A	11/26/2014	11/25/2015

6.3 EUT Setup:

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

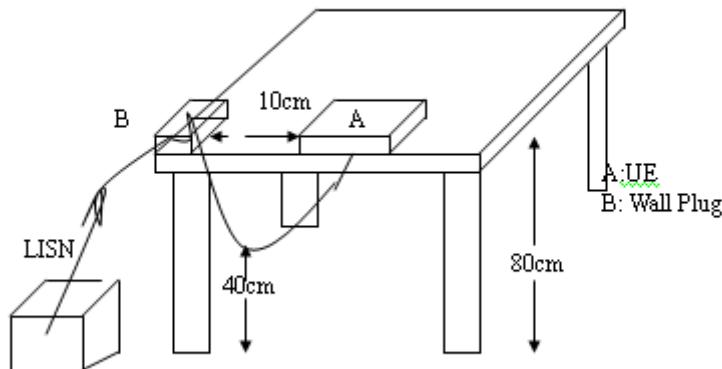
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6.4 Test SET-UP (Block Diagram of Configuration)



6.5 Measurement Procedure:

1. The EUT was placed on a table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all phases of power being supplied by given UE are completed

6.6 Measurement Result:

The initial step in collecting conducted data is a spectrum analyzer peak scan of the measurement range. Significant peaks are then marked as shown on the following data page, and these signals are then quasi-peaked.

Note: Refer to next page for measurement data and plots.

Note2: The * reveals the worst-case results that closet to the limit

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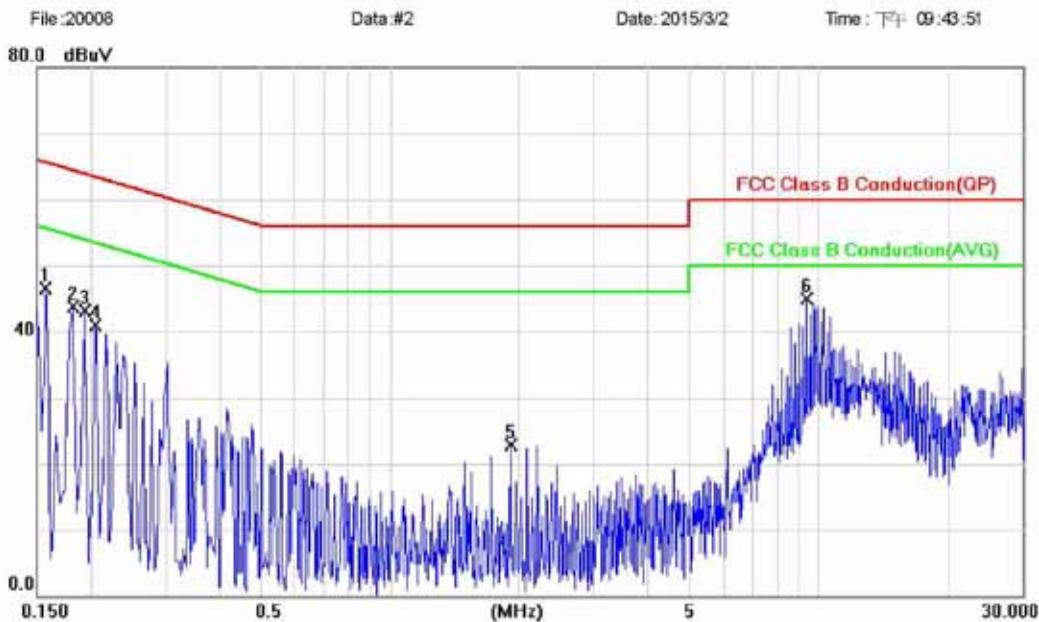
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AC POWER LINE CONDUCTED EMISSION TEST DATA

Operation Mode:	Operation mode			Test Date:	Mar. 02, 2015
Temperature:	24	Humidity:	66 %	Test By:	Tin

Site: ConductionRoom
 Phase: **L1**
 Temperature: 24 °C
 Limit: FCC Class B Conduction(QP)
 Power: AC 120V/60Hz
 Humidity: 66%
 Mode: Operation
 Note: Adapter:GT-81081-6015-T3

Conducted Emission



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dB	Detector	Comment
1		0.1580	46.36	0.05	46.41	65.57	-19.16	peak
2		0.1820	43.57	0.06	43.63	64.39	-20.76	peak
3		0.1940	42.95	0.06	43.01	63.86	-20.85	peak
4		0.2060	40.83	0.06	40.89	63.37	-22.48	peak
5		1.9100	22.87	0.12	22.99	56.00	-33.01	peak
6 *		9.3740	44.54	0.32	44.86	60.00	-15.14	peak

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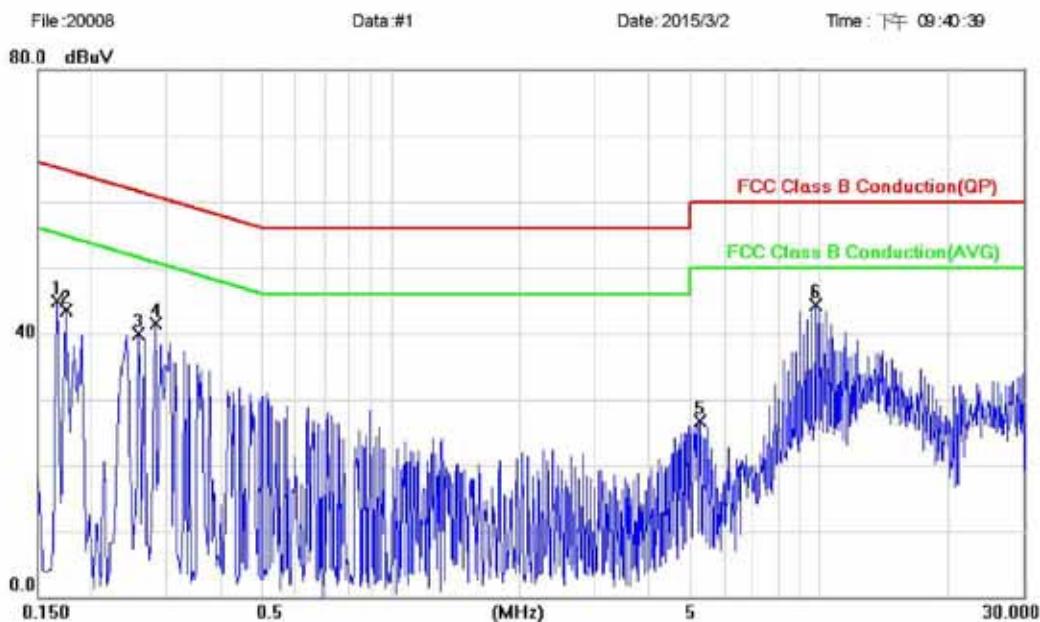
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Site: ConductionRoom
 Limit: FCC Class B Conduction(QP)
 Mode: Operation
 Note: Adapter:GT-81081-6015-T3

Phase: **N**
 Power: AC 120V/60Hz

Temperature: 24 °C
 Humidity: 66%

Conducted Emission



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over	Detector	Comment
			Level	Factor	ment				
1		0.1660	44.90	0.05	44.95	65.16	-20.21	peak	
2		0.1740	43.49	0.05	43.54	64.77	-21.23	peak	
3		0.2580	39.87	0.06	39.93	61.50	-21.57	peak	
4		0.2820	41.47	0.06	41.53	60.76	-19.23	peak	
5		5.2500	26.57	0.20	26.77	60.00	-33.23	peak	
6 *		9.7740	44.06	0.34	44.40	60.00	-15.60	peak	

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7 PEAK OUTPUT POWER MEASUREMENT

7.1 Standard Applicable:

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt.

If the transmitting antenna of directional gain greater than 6dBi are used the peak output power form the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

7.2 Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Power Meter	Anritsu	ML2495A	1005007	12/20/2014	12/19/2015
Power Sensor	Anritsu	MA2411B	917032	12/20/2014	12/19/2015
Spectrum Analyzer	Agilent	E4446A	MY51100003	05/19/2014	05/18/2015
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Low Loss Cable	HUBER+SUHNER	SUCOFLEX 104PEA	N/A	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016

7.3 Test Set-up:



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7.4 Measurement Procedure:

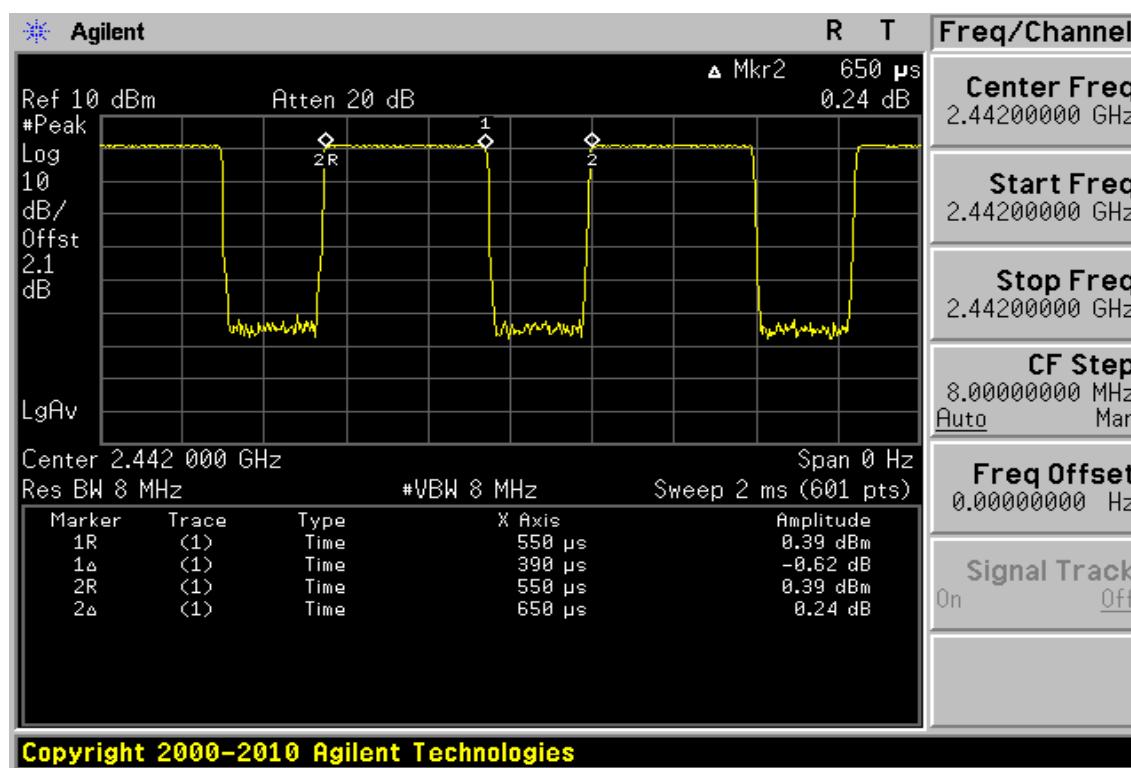
1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance V03r02.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.

Power Meter:

It is used as the auxiliary test equipment to conduct the output power measurement.

4. Record the max. Reading as observed from Power Meter.
5. Repeat above procedures until all test default channel measured was complete.

Duty Factor:



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7.5 Measurement Result:

BT4.0 mode:

CH	Frequency (MHz)	Peak Power Output(dBm)	Required Limit
0	2402	1.14	1 Watt = 30 dBm
20	2442	1.11	1 Watt = 30 dBm
39	2480	-1.30	1 Watt = 30 dBm

CH	Frequency (MHz)	Average Power Output(dBm)	Required Limit
0	2402	-1.30	1 Watt = 30 dBm
20	2442	-1.34	1 Watt = 30 dBm
39	2480	-3.78	1 Watt = 30 dBm

*Note: Measured by power meter, as cable loss+ Duty cycle factor that offsets on the power meter

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8 6dB BANDWIDTH

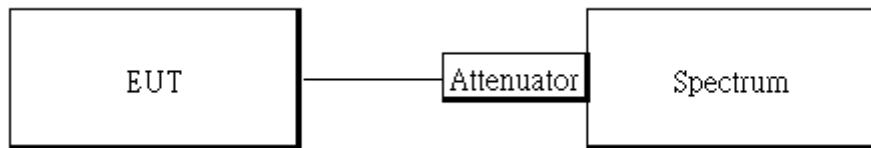
8.1 Standard Applicable

The minimum 6 dB bandwidth shall be at least 500 kHz .

8.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4446A	MY51100003	05/19/2014	05/18/2015
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016

8.3 Test Set-up:



8.4 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance V03r02.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as RBW = 100 kHz, VBW = 3*RBW, Span = 5MHz, Detector=Peak, Sweep=auto.
4. Mark the peak frequency and -6dB (upper and lower) frequency.
5. Repeat above procedures until all test default channel measured were complete.

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8.5 Measurement Result:

BT4.0 mode

Frequency (MHz)	Bandwidth (kHz)	Bandwidth (kHz)	Result
2402	690.982	> 500	PASS
2442	681.527	> 500	PASS
2480	707.370	> 500	PASS

* Note: The arrow “->” reveals X decibel level

Note: Refer to next page for plots.

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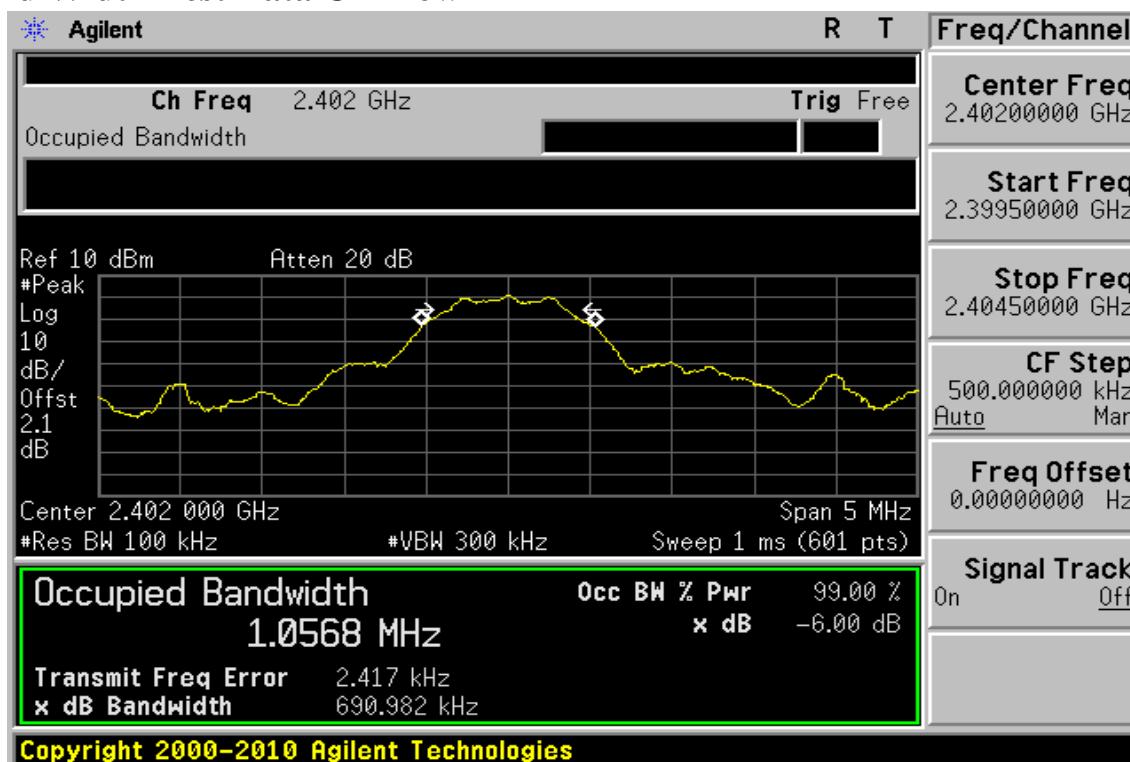
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BT4.0 mode

6dB Band Width Test Data CH-Low



6dB Band Width Test Data CH-Mid



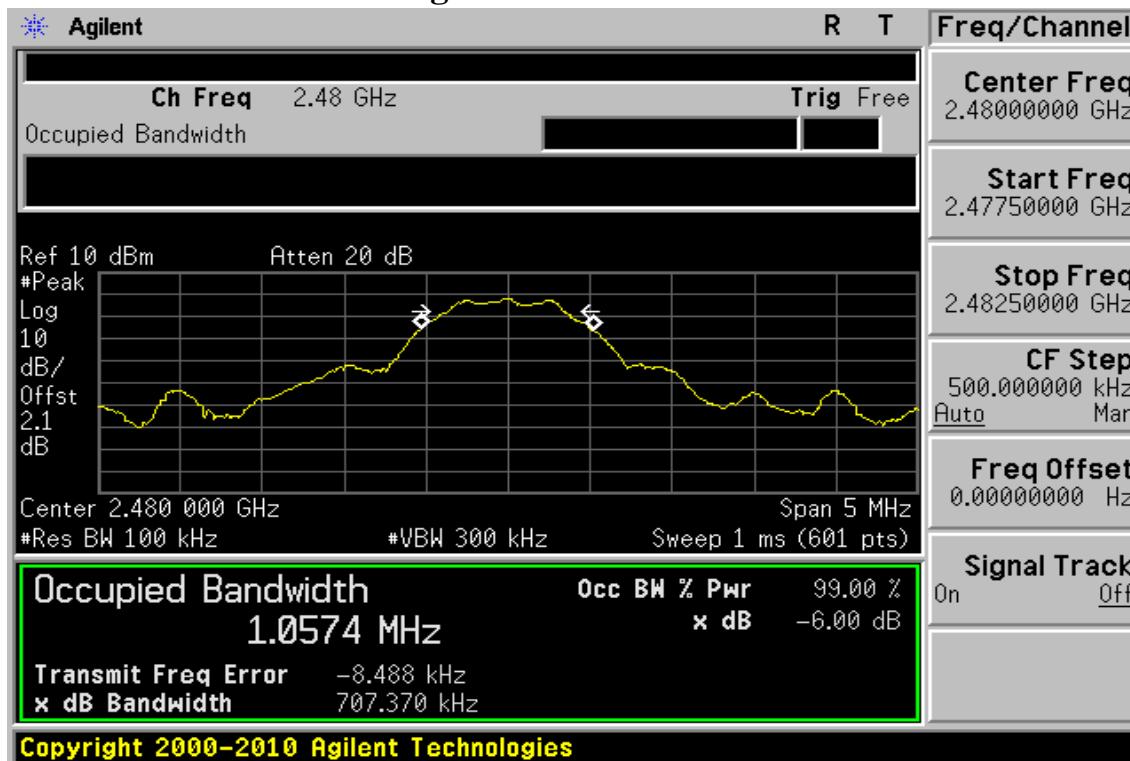
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6dB Band Width Test Data CH-High



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9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

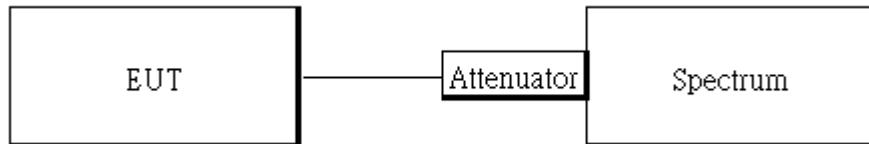
9.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

9.2 Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4446A	MY51100003	05/19/2014	05/18/2015
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016

9.3 Test SET-UP:



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9.3.1 Measurement Procedure

Conducted Band Edge:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance V03r02.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
5. Set the spectrum analyzer as RBW, VBW=300KHz, Detector = Peak, Sweep = auto
6. Mark the highest reading of the emission as the reference level measurement.
7. Set DL as the limit = reading on marker 1 – 20dBm
8. Marker on frequency, 2.3999GHz and 2.4836GHz, and examine shall 100 KHz immediately outside the authorized (2400~2483.5) be attenuated by 20dB at least relative to the maximum emission of power.
9. Repeat above procedures until all default test channel (low, middle, and high) was complete.

Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance V03r02.
3. Set RBW = 100K & VBW \geq 300K, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

9.3.2 Measurement Result

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

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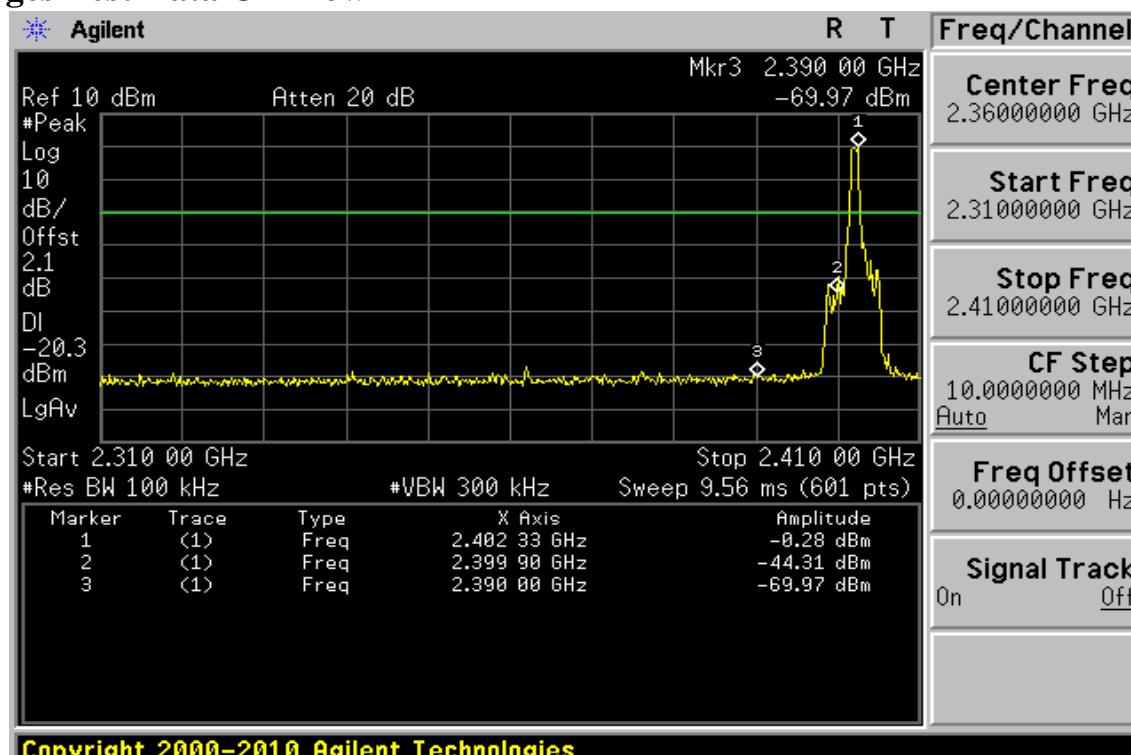
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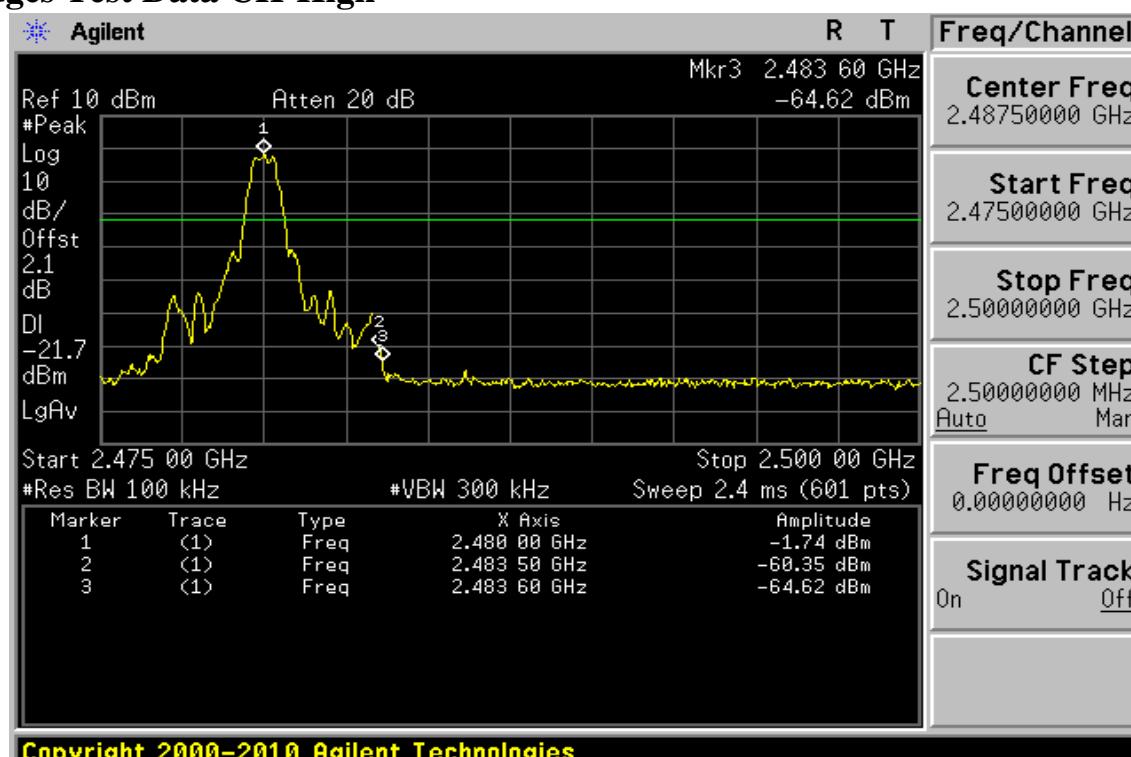
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BT4.0 mode

Band Edges Test Data CH-Low



Band Edges Test Data CH-High



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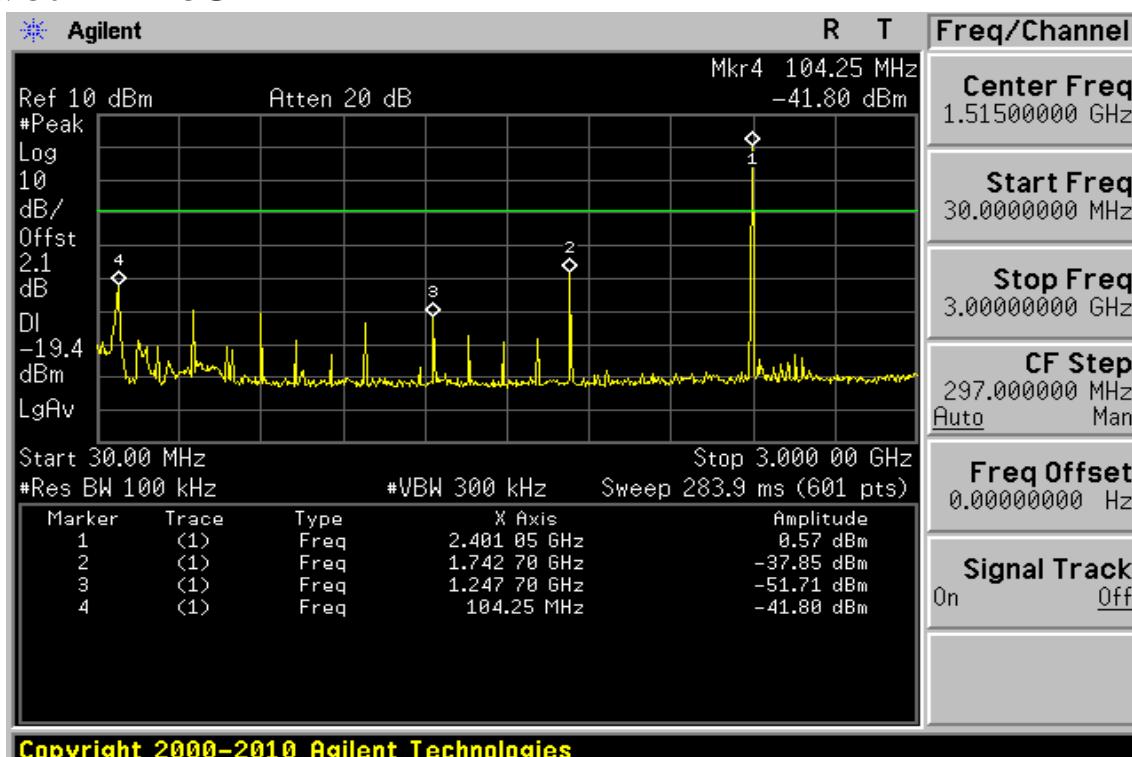
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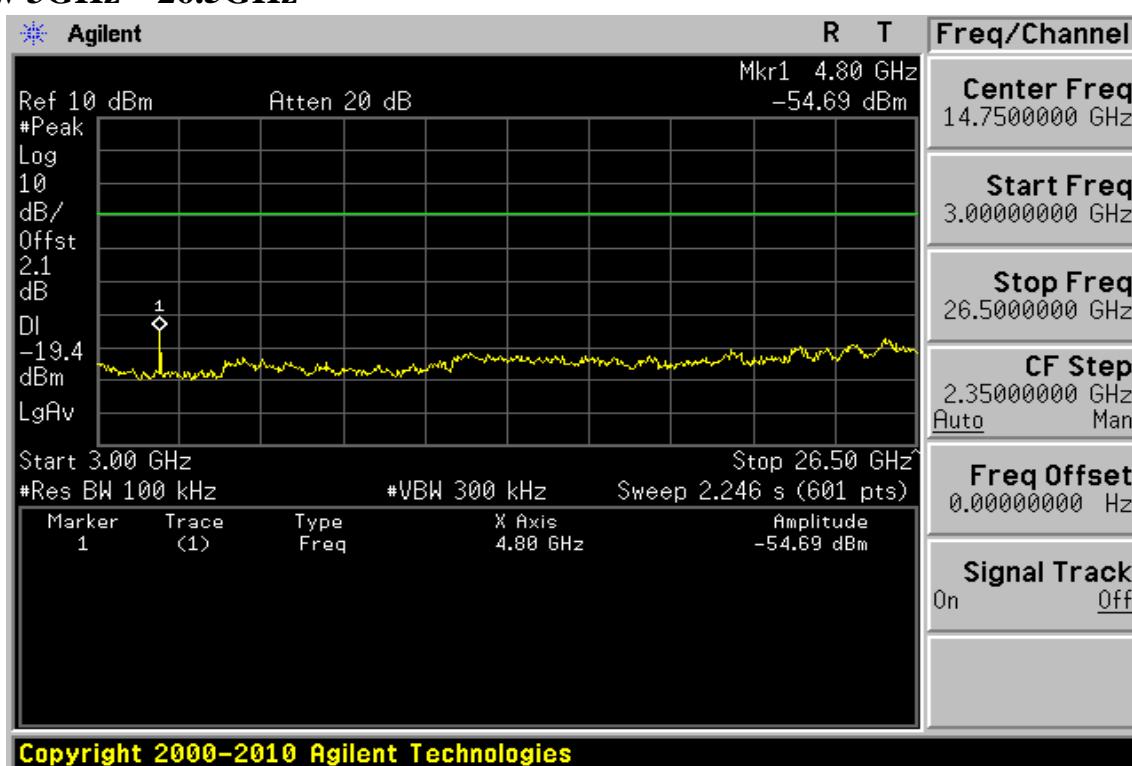
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Conducted Spurious Emission Measurement Result

CH-Low 30MHz – 3GHz



CH-Low 3GHz – 26.5GHz



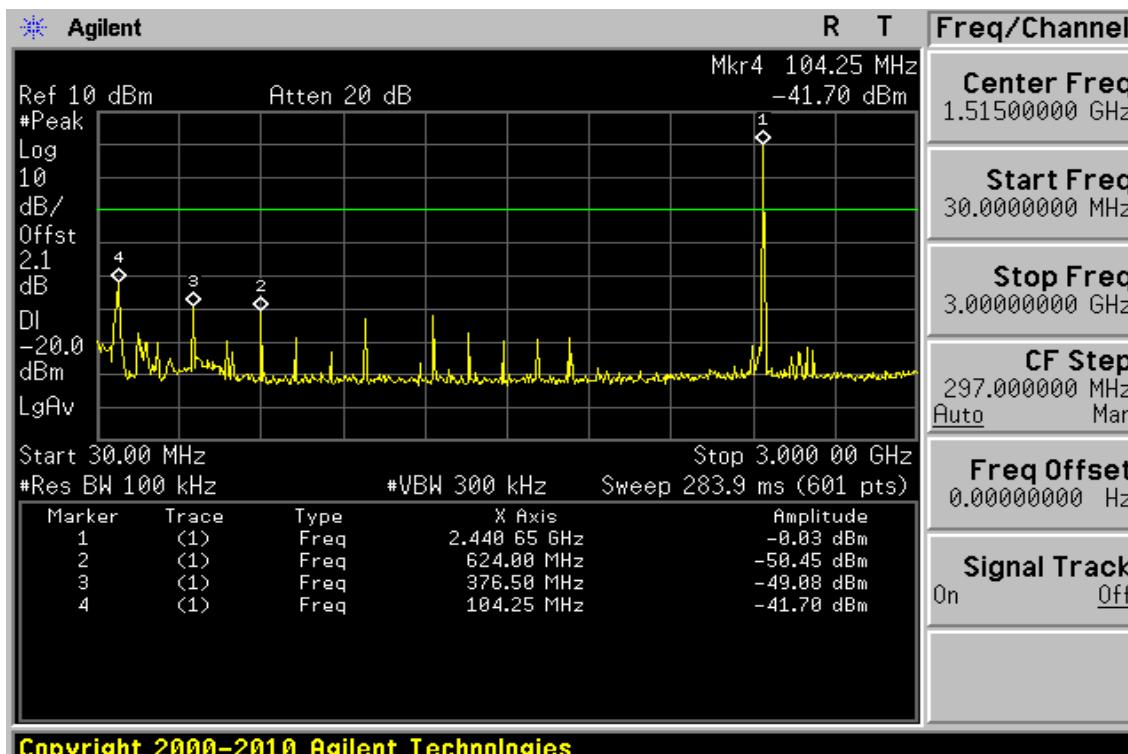
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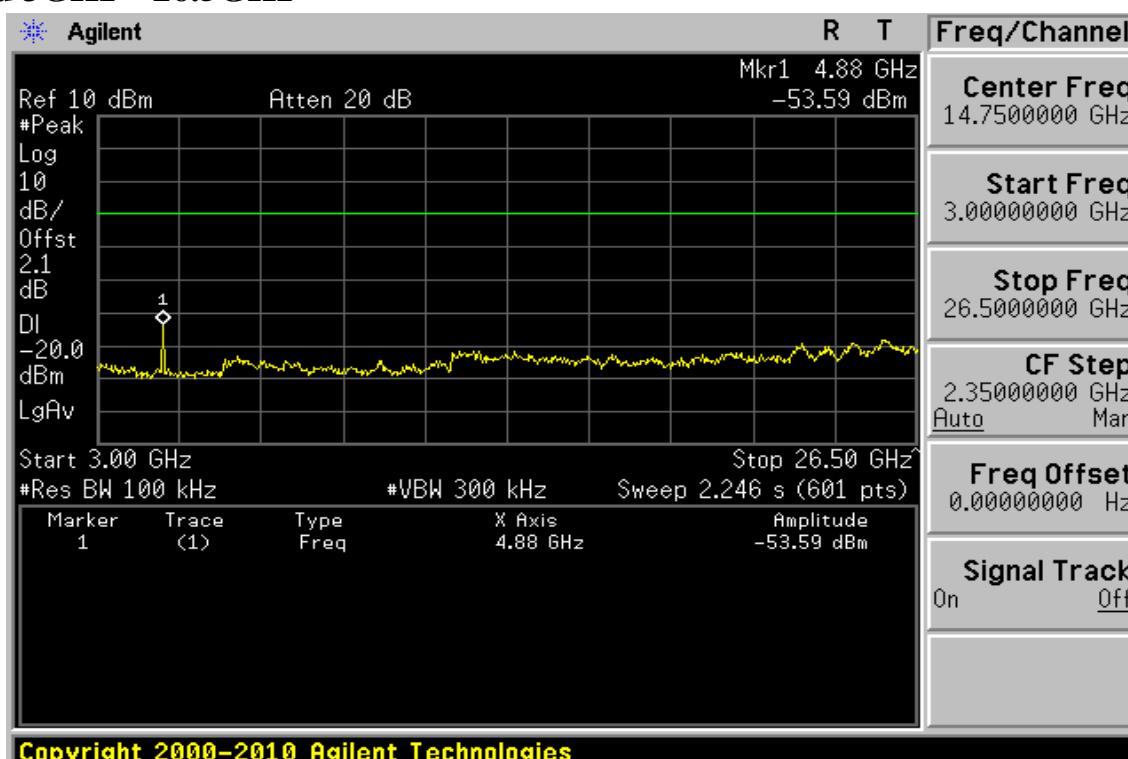
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CH-Mid 30MHz – 3GHz



CH-Mid 3GHz – 26.5GHz



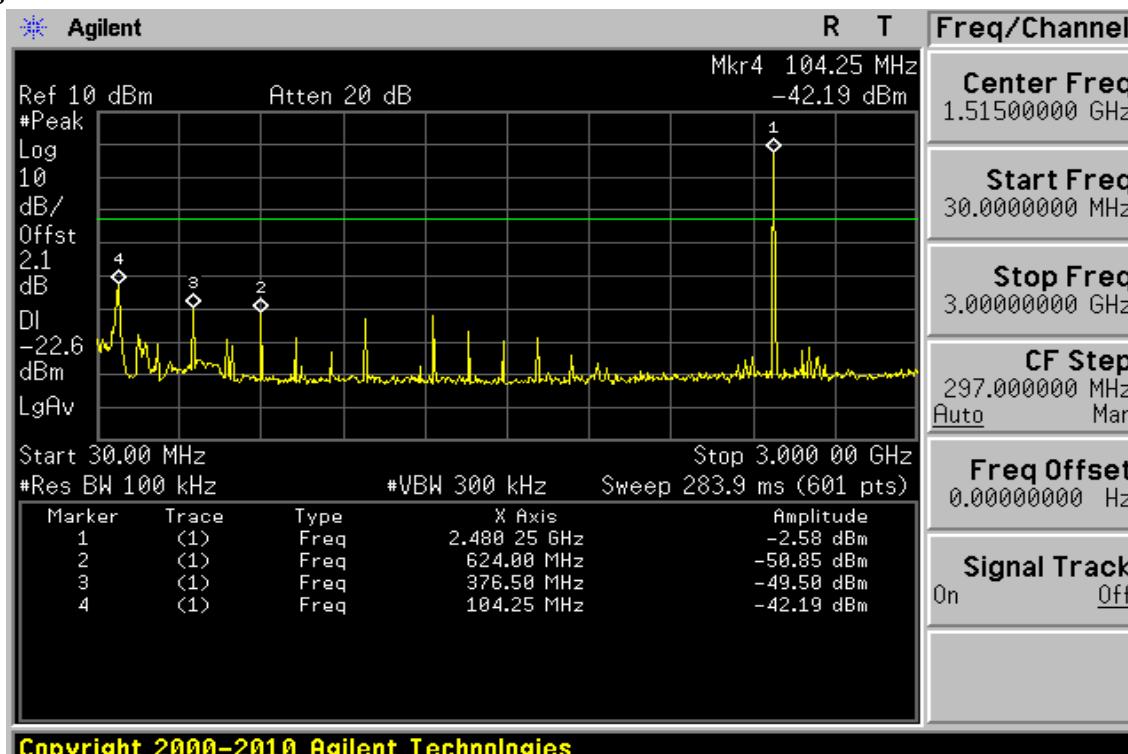
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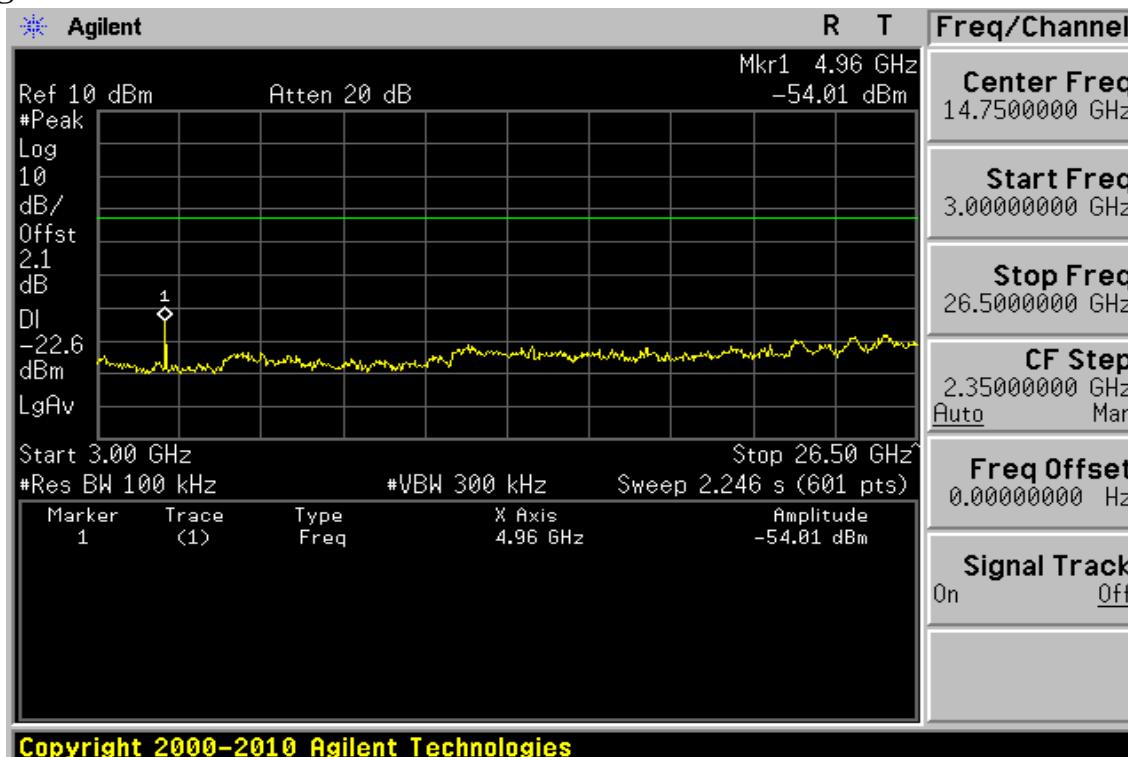
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CH-High 30MHz – 3GHz



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CH- High 3GHz – 26.5GHz



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10 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

10.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands must also comply with the §15.209 limit as below.

And according to §15.33(a) (1), for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(KHz)	300
0.490-1.705	24000/F(KHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dB μ V/m) = 20 log Emission level (dB μ V/m)

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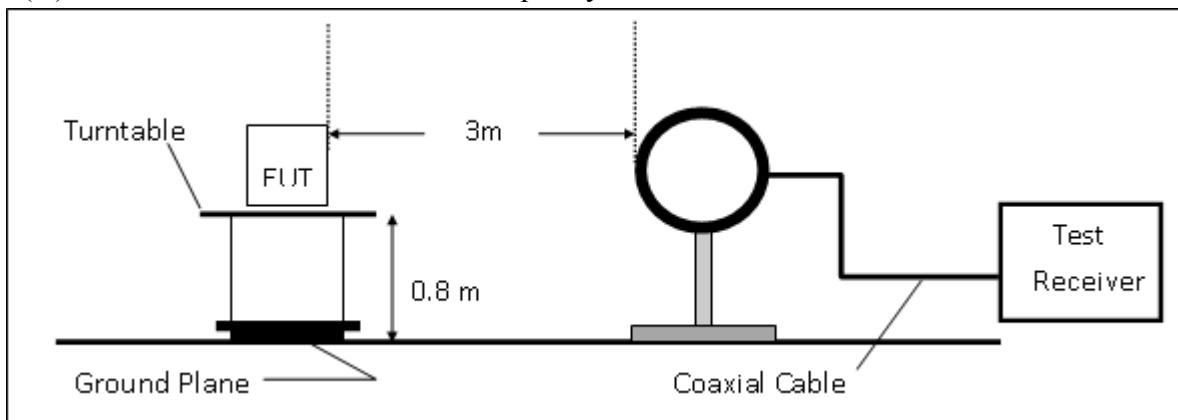
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10.2 Measurement Equipment Used

966 Chamber					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESCI7	100760	05/26/2014	05/25/2015
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	12/22/2014	12/21/2015
Spectrum Analyzer	R&S	FSV-30	101398	10/07/2014	10/06/2015
Loop Antenna	ETS.LINDGREN	6502	00148045	07/03/2014	07/02/2015
Bilog Antenna	SCHWAZBECK	VULB9168	378	12/23/2014	12/22/2015
Horn antenna	ETS.LINDGREN	3117	123995	05/19/2014	05/18/2015
Horn Antenna	Schwarzbeck	BBHA9170	184	12/25/2014	12/24/2015
Pre-Amplifier	Agilent	8447D	2944A07676	01/02/2015	01/01/2016
Pre-Amplifier	Agilent	8449B	3008A00578	01/02/2015	01/01/2016
Pre-Amplifier	EMC Instruments Corp.	EMC184045	980135	01/02/2015	01/01/2016
Filter 2400-2483.5 MHz	EWT	EWT-14-0166	M2	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	004	01/02/2015	01/01/2016
Turn Table	HD	DT420	N/A	N.C.R	N.C.R
Antenna Tower	HD	MA240-N	240/657	N.C.R	N.C.R
Controller	HD	HD100	N/A	N.C.R	N.C.R
Low Loss Cable	Huber Suhner	966_Rx	9	01/02/2015	01/01/2016

10.3 Test SET-UP

(A) Radiated Emission Test Set-UP Frequency Below 30MHz.

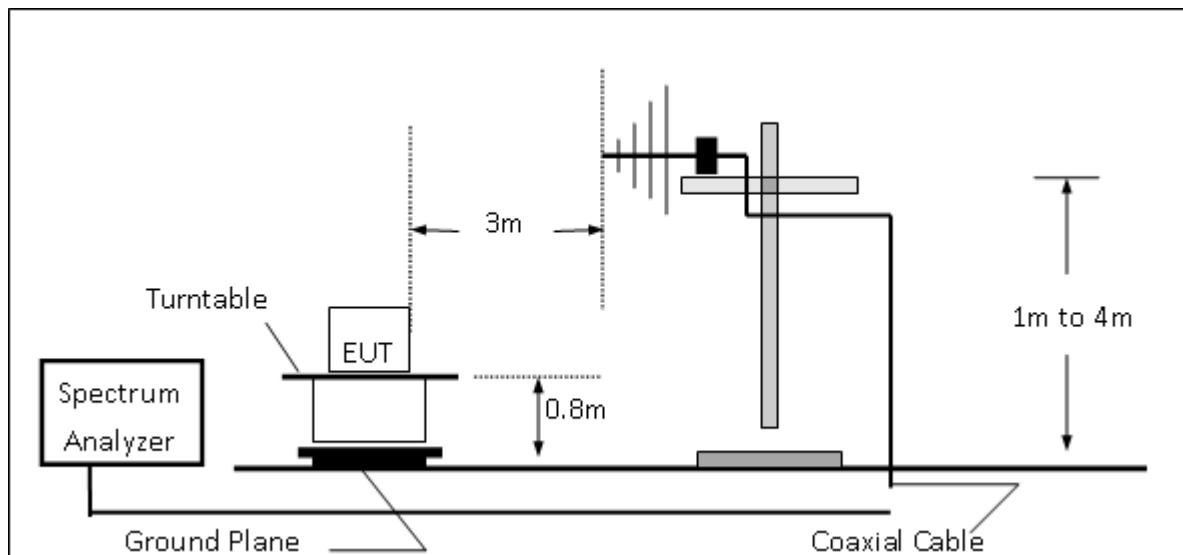


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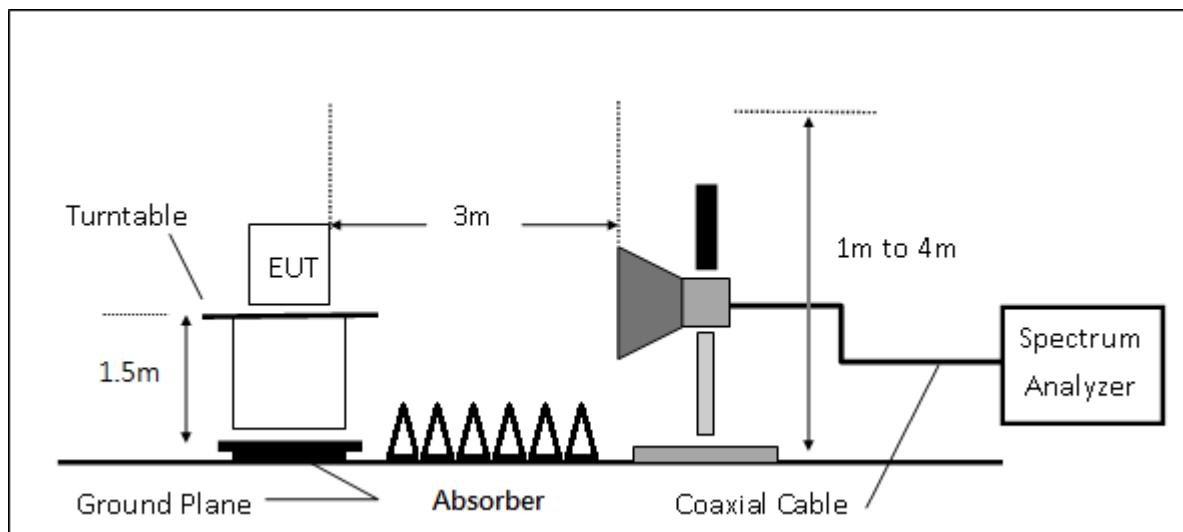
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(B) Radiated Emission Test Set-Up, Frequency form 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



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10.4 Measurement Procedure

1. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance V03r02.
2. The EUT was placed on a turn table with 0.8m for frequency < 1GHz and 1.5m for frequency > 1GHz above ground plane.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Set the spectrum analyzer as RBW=120 kHz and VBW=300 kHz for Peak Detector (PK) and Quasi-peak (QP) at frequency below 1 GHz.
6. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Peak Detector at frequency above 1 GHz.
7. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW \geq 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.
8. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.
9. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
10. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. On spectrum, change spectrum mode in linear display mode, and reduce VBW = 10Hz if average reading is measured.
11. Repeat above procedures until all default test channel measured were complete.

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10.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where	FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
	RA = Reading Amplitude	AG = Amplifier Gain
	AF = Antenna Factor	

Actual FS(dB μ V/m) = SPA. Reading level(dB μ V) + Factor(dB)

Factor(dB) = Antenna Factor(dB μ V/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

Note :

“F” : denotes Fundamental Frequency. ; “H” : denotes Harmonic Frequency.

“E” : denotes Band Edge Frequency. ; “S” : denotes Spurious Frequency.

10.6 Test Results of Radiated Spurious Emissions form 9 KHz to 30 MHz

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) was not reported.

10.7 Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

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Radiated Band Edge Measurement Result (BT4.0 mode)

Operation Band	:BT4.0	Test Date	:2015-02-24
Fundamental Frequency	:2402 MHz	Temp./Humi.	:24 deg_C /59 RH
Operation Mode	:Band Edge LOW	Engineer	:Curry
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			Mode	Reading Level dB μ V				
2390.00	E	Average		30.20	5.16	35.36	54.00	-18.64
2390.00	E	Peak		41.13	5.16	46.29	74.00	-27.71

Operation Band	:BT4.0	Test Date	:2015-02-24
Fundamental Frequency	:2402 MHz	Temp./Humi.	:24 deg_C /59 RH
Operation Mode	:Band Edge LOW	Engineer	:Curry
EUT Pol.	:H Plane	Measurement Antenna Pol.	:HORIZONTAL

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			Mode	Reading Level dB μ V				
2390.00	E	Average		30.52	5.16	35.68	54.00	-18.32
2390.00	E	Peak		41.22	5.16	46.38	74.00	-27.62

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Operation Band :BT4.0
 Fundamental Frequency :2480 MHz
 Operation Mode : Band Edge HIGH
 EUT Pol. :H Plane

Test Date :2015-02-24
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Curry
 Measurement Antenna Pol. :VERTICAL

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
						FS dB μ V/m	Margin dB
2483.50	E	Average	31.58	6.01	37.59	54.00	-16.41
2483.50	E	Peak	42.14	6.01	48.15	74.00	-25.85

Operation Band :BT4.0
 Fundamental Frequency :2480 MHz
 Operation Mode : Band Edge HIGH
 EUT Pol. :H Plane

Test Date :2015-02-24
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Curry
 Measurement Antenna Pol. :HORIZONTAL

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
						FS dB μ V/m	Margin dB
2483.50	E	Average	32.98	6.01	38.99	54.00	-15.01
2483.50	E	Peak	48.03	6.01	54.04	74.00	-19.96

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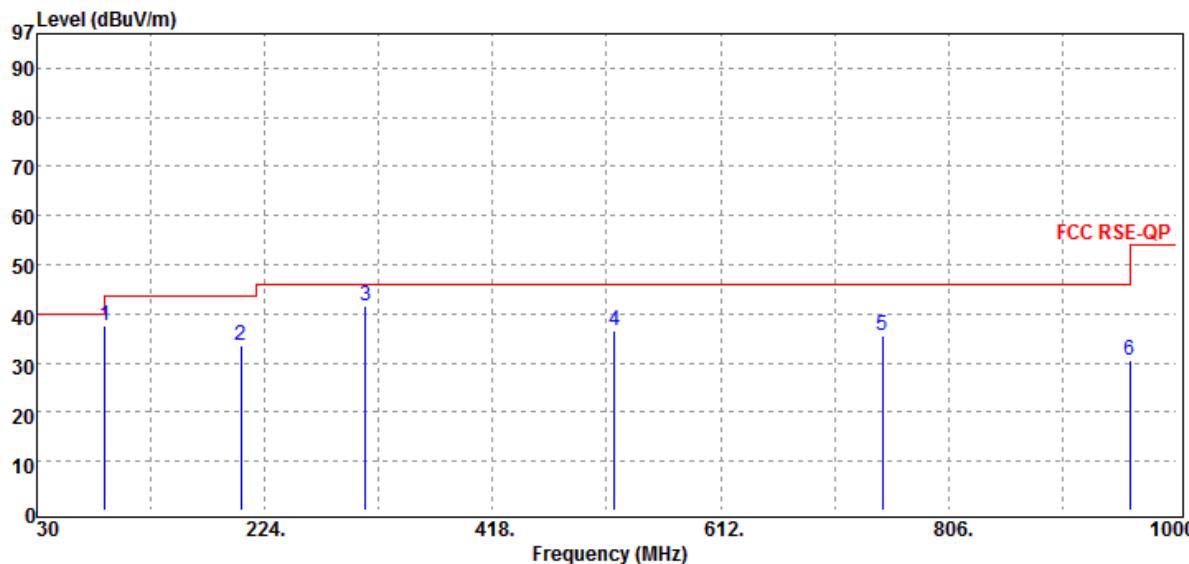
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Radiated Spurious Emission Measurement Result (BT4.0 mode)

For Frequency from 30MHz to 1000MHz

Operation Band	:BT4.0	Test Date	:2015-02-24
Fundamental Frequency	:2402 MHz	Temp./Humi.	:24 deg_C /59 RH
Operation Mode	:TX LOW	Engineer	:Curry
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			Level dB μ V				
88.20	S	Peak	52.79	-15.13	37.66	43.50	-5.84
203.63	S	Peak	45.02	-11.57	33.45	43.50	-10.05
309.36	S	Peak	49.29	-7.67	41.62	46.00	-4.38
521.79	S	Peak	40.90	-4.37	36.53	46.00	-9.47
749.74	S	Peak	35.44	0.27	35.71	46.00	-10.29
960.23	S	Peak	26.88	3.66	30.54	54.00	-23.46

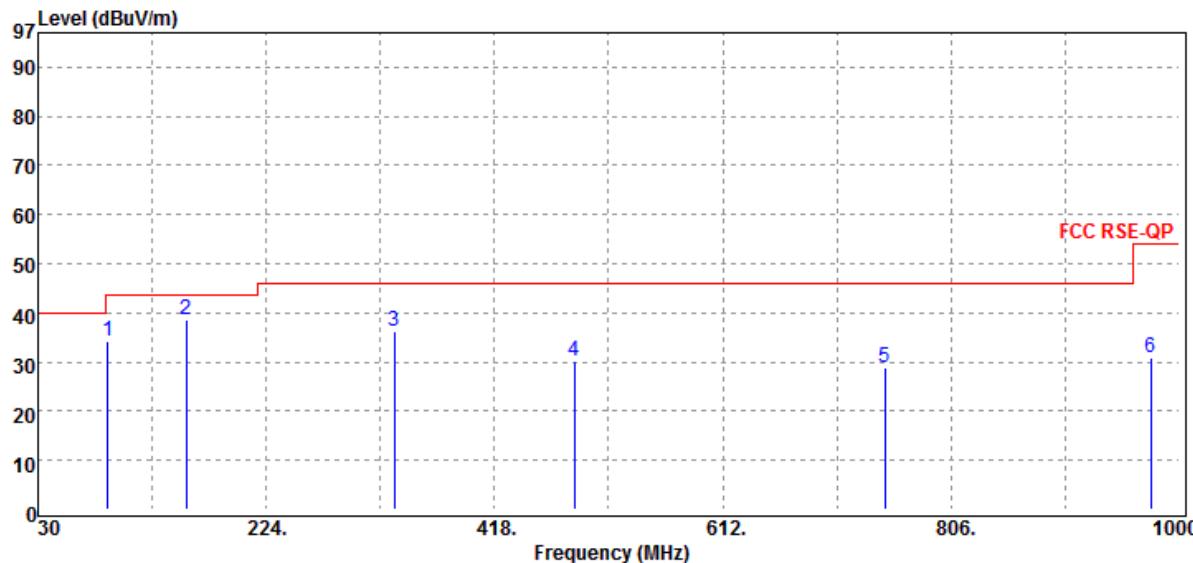
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Operation Band :BT4.0
 Fundamental Frequency :2402 MHz
 Operation Mode :TX LOW
 EUT Pol. :H Plane

Test Date :2015-02-24
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Curry
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			PK/QP/AV	Reading Level dB μ V				
89.17	S	Peak	49.68	-15.33	34.35	43.50	-9.15	
156.10	S	Peak	47.71	-8.98	38.73	43.50	-4.77	
332.64	S	Peak	43.90	-7.67	36.23	46.00	-9.77	
485.90	S	Peak	34.69	-4.37	30.32	46.00	-15.68	
749.74	S	Peak	28.62	0.27	28.89	46.00	-17.11	
975.75	S	Peak	27.55	3.48	31.03	54.00	-22.97	

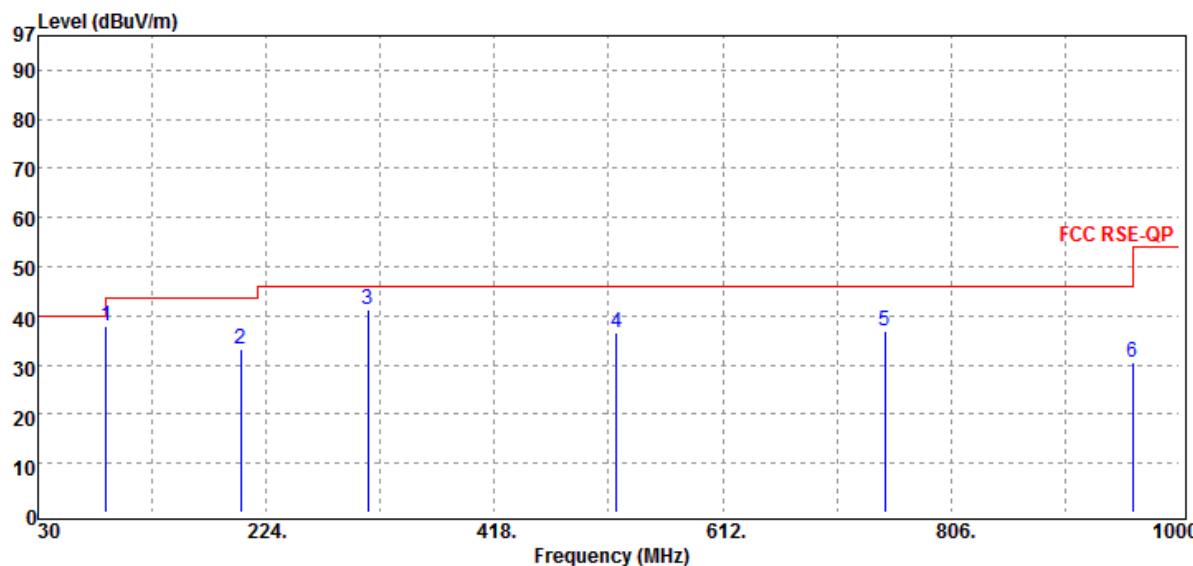
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Operation Band :BT4.0
 Fundamental Frequency :2442 MHz
 Operation Mode :TX MID
 EUT Pol. :H Plane

Test Date :2015-02-24
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Curry
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			PK/QP/AV	Reading Level dB μ V				
88.20	S	Peak	52.94	-15.13	37.81	43.50	-5.69	
202.66	S	Peak	44.96	-11.63	33.33	43.50	-10.17	
310.33	S	Peak	48.95	-7.64	41.31	46.00	-4.69	
521.79	S	Peak	40.99	-4.37	36.62	46.00	-9.38	
749.74	S	Peak	36.69	0.27	36.96	46.00	-9.04	
960.23	S	Peak	26.93	3.66	30.59	54.00	-23.41	

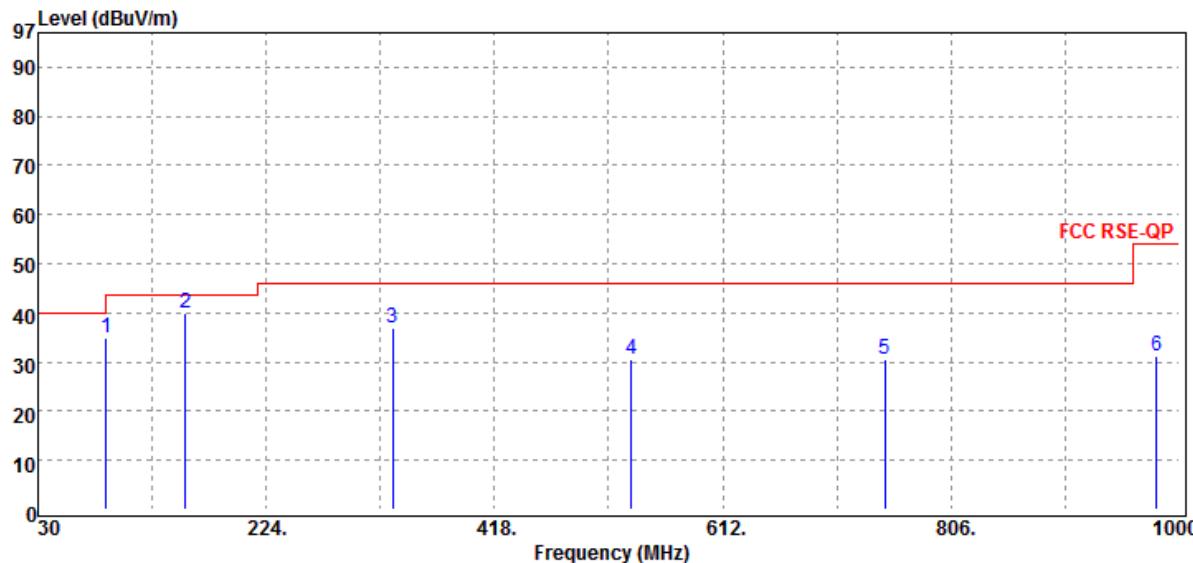
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Operation Band :BT4.0
 Fundamental Frequency :2442 MHz
 Operation Mode :TX MID
 EUT Pol. :H Plane

Test Date :2015-02-24
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Curry
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor	Actual FS	Limit @3m	Margin
			PK/QP/AV	Reading Level dB μ V				
88.20	S	Peak	49.91	49.91	-15.13	34.78	43.50	-8.72
155.13	S	Peak	49.12	49.12	-9.03	40.09	43.50	-3.41
331.67	S	Peak	44.64	44.64	-7.68	36.96	46.00	-9.04
534.40	S	Peak	34.58	34.58	-4.00	30.58	46.00	-15.42
749.74	S	Peak	30.23	30.23	0.27	30.50	46.00	-15.50
980.60	S	Peak	27.65	27.65	3.41	31.06	54.00	-22.94

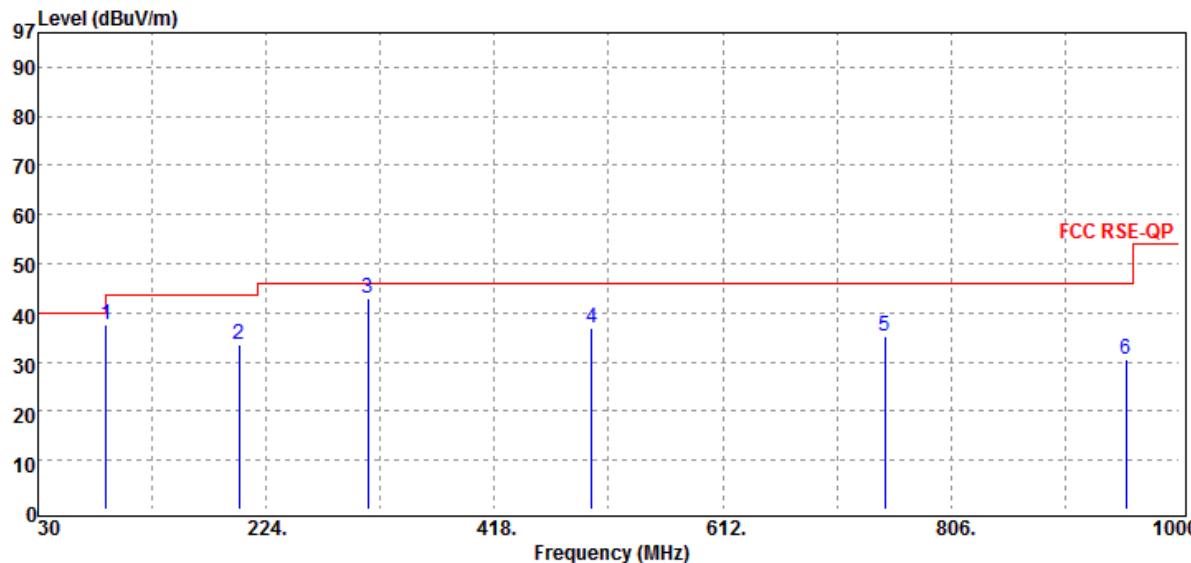
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Operation Band :BT4.0
 Fundamental Frequency :2480 MHz
 Operation Mode :TX HIGH
 EUT Pol. :H Plane

Test Date :2015-02-24
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Curry
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			PK/QP/AV	Reading Level dB μ V				
88.20	S	Peak	52.56	-15.13	37.43	43.50	-6.07	
200.72	S	Peak	45.35	-11.77	33.58	43.50	-9.92	
310.33	S	Peak	50.54	-7.64	42.90	46.00	-3.10	
500.45	S	Peak	41.10	-4.34	36.76	46.00	-9.24	
749.74	S	Peak	34.90	0.27	35.17	46.00	-10.83	
954.41	S	Peak	27.01	3.49	30.50	46.00	-15.50	

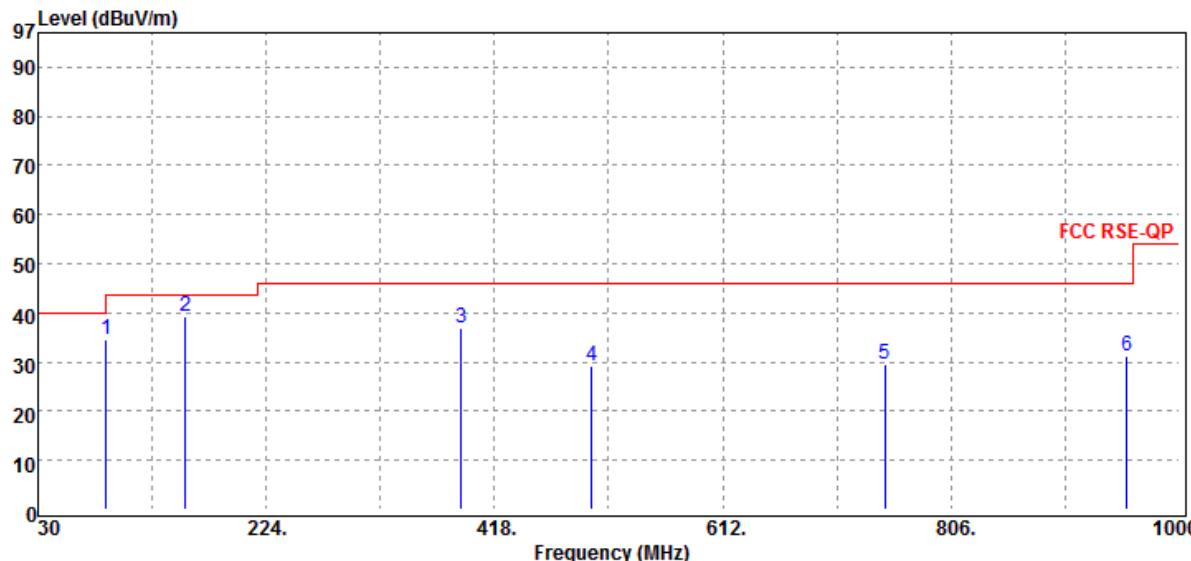
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Operation Band :BT4.0
 Fundamental Frequency :2480 MHz
 Operation Mode :TX HIGH
 EUT Pol. :H Plane

Test Date :2015-02-24
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Curry
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			PK/QP/AV	Reading Level dB μ V				
88.20	S	Peak	49.67	-15.13	34.54	43.50	-8.96	
155.13	S	Peak	48.44	-9.03	39.41	43.50	-4.09	
389.87	S	Peak	42.99	-6.15	36.84	46.00	-9.16	
500.45	S	Peak	33.63	-4.34	29.29	46.00	-16.71	
749.74	S	Peak	29.33	0.27	29.60	46.00	-16.40	
955.38	S	Peak	27.67	3.52	31.19	46.00	-14.81	

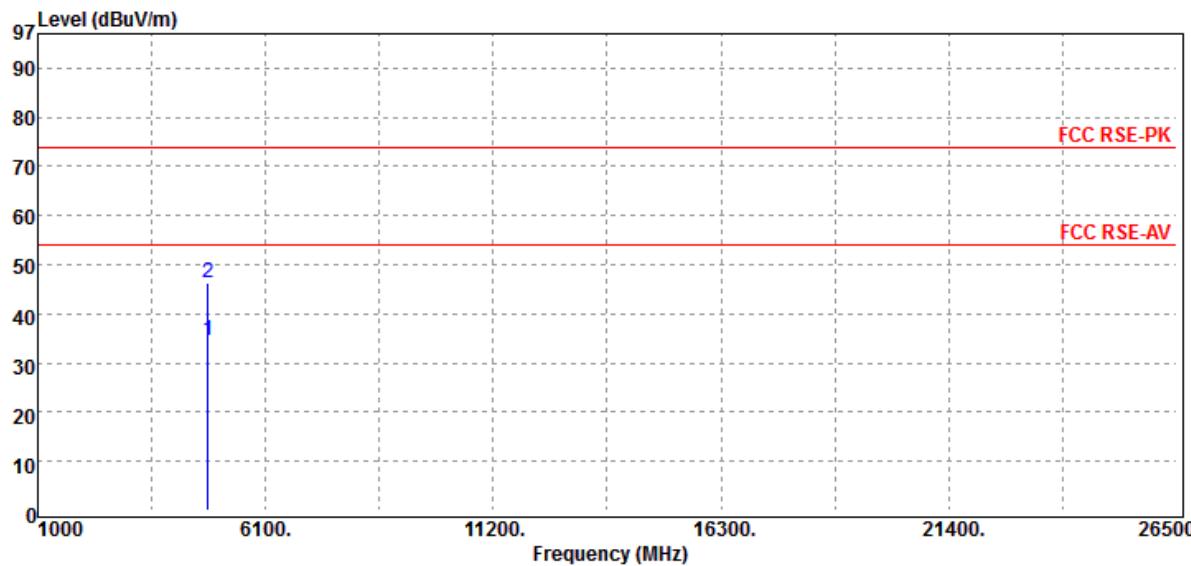
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For Frequency above 1GHz

Operation Band	:BT4.0	Test Date	:2015-02-24
Fundamental Frequency	:2402 MHz	Temp./Humi.	:24 deg_C /59 RH
Operation Mode	:TX LOW	Engineer	:Curry
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4804.00	H	Average	25.08	9.56	34.64	54.00	-19.36
4804.00	H	Peak	36.78	9.56	46.34	74.00	-27.66

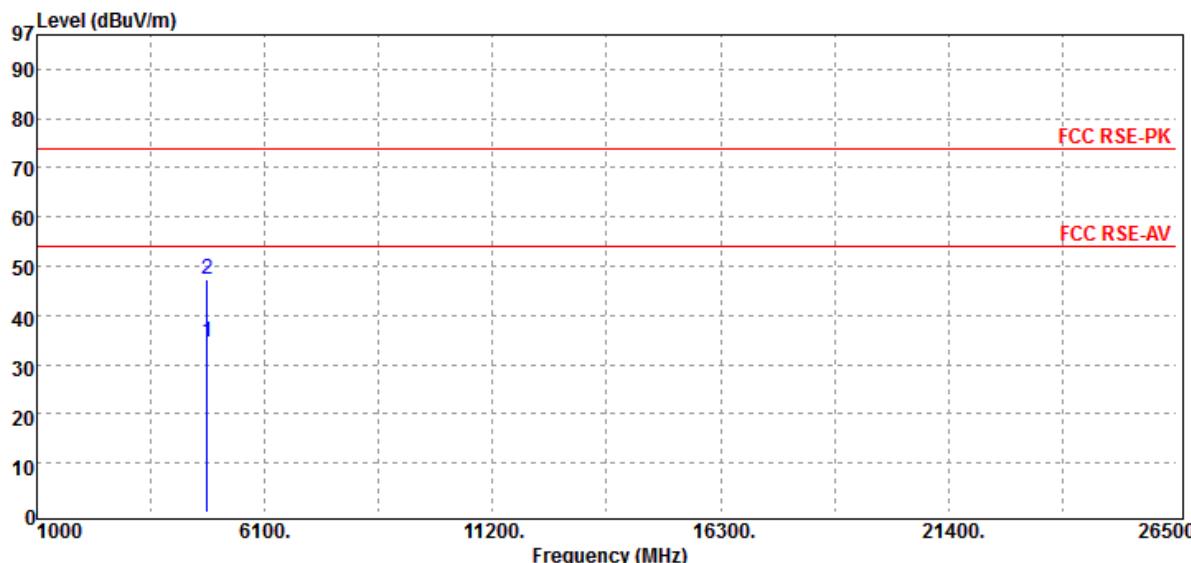
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Operation Band :BT4.0
 Fundamental Frequency :2402 MHz
 Operation Mode :TX LOW
 EUT Pol. :H Plane

Test Date :2015-02-24
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Curry
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum	Factor	Actual FS	Limit @3m	Margin
			PK/QP/AV				
4804.00	H	Average	25.16	9.56	34.72	54.00	-19.28
4804.00	H	Peak	37.66	9.56	47.22	74.00	-26.78

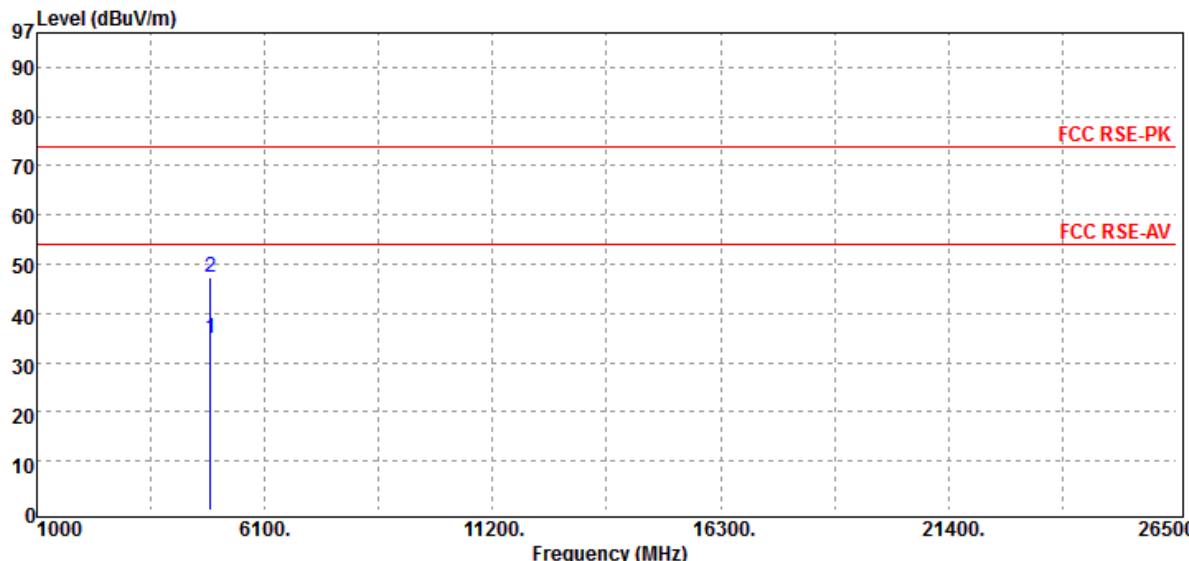
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Operation Band :BT4.0
 Fundamental Frequency :2442 MHz
 Operation Mode :TX MID
 EUT Pol. :H Plane

Test Date :2015-02-24
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Curry
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			Reading				
		PK/QP/AV	dB μ V				
4884.00	H	Average	25.10	9.85	34.95	54.00	-19.05
4884.00	H	Peak	37.39	9.85	47.24	74.00	-26.76

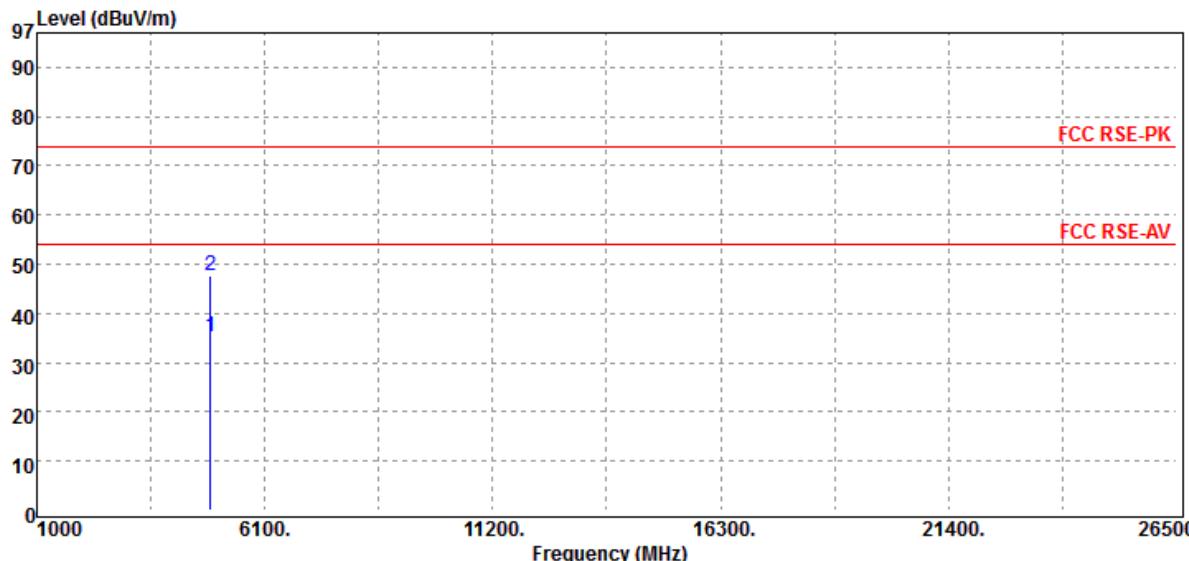
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Operation Band :BT4.0
 Fundamental Frequency :2442 MHz
 Operation Mode :TX MID
 EUT Pol. :H Plane

Test Date :2015-02-24
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Curry
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			Reading				
		PK/QP/AV	dB μ V				
4884.00	H	Average	25.26	9.85	35.11	54.00	-18.89
4884.00	H	Peak	37.85	9.85	47.70	74.00	-26.30

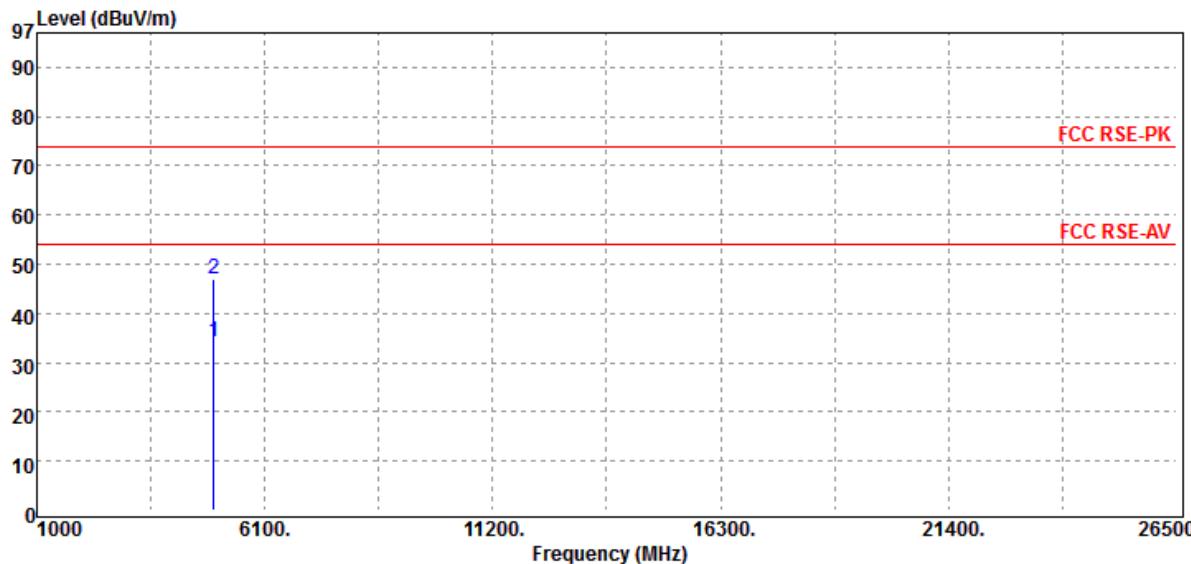
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Operation Band :BT4.0
 Fundamental Frequency :2480 MHz
 Operation Mode :TX HIGH
 EUT Pol. :H Plane

Test Date :2015-02-24
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Curry
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum	Factor	Actual FS	Limit @3m	Margin
			PK/QP/AV				
4960.00	H	Average	24.22	9.86	34.08	54.00	-19.92
4960.00	H	Peak	36.97	9.86	46.83	74.00	-27.17

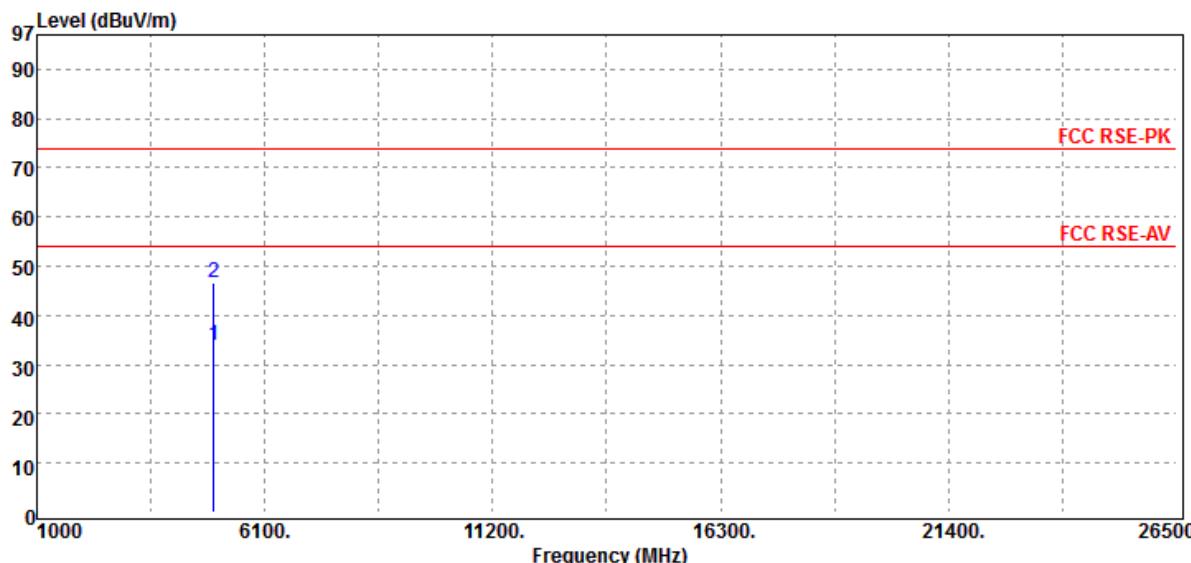
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Operation Band :BT4.0
 Fundamental Frequency :2480 MHz
 Operation Mode :TX HIGH
 EUT Pol. :H Plane

Test Date :2015-02-24
 Temp./Humi. :24 deg_C /59 RH
 Engineer :Curry
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum	Factor	Actual FS	Limit @3m	Margin
			Reading				
		PK/QP/AV	dB μ V	dB	dB μ V/m	dB μ V/m	dB
4960.00	H	Average	24.14	9.86	34.00	54.00	-20.00
4960.00	H	Peak	36.73	9.86	46.59	74.00	-27.41

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11 PEAK POWER SPECTRAL DENSITY

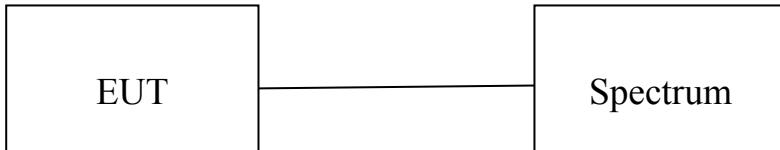
11.1 Standard Applicable:

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

11.2 Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4446A	MY51100003	05/19/2014	05/18/2015
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016

11.3 Test Set-up:



11.4 Measurement Procedure:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance V03r02.
2. Set the span to 1.5 times the DTS channel bandwidth.
3. Set the RBW \geq 3 kHz.
4. Set the VBW \geq 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

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11.5 Measurement Result:

BT4.0 mode

Frequency MHz	RF Power Density (dBm)	Limit (dBm)	Result
2402	-15.00	8	PASS
2442	-14.98	8	PASS
2480	-17.28	8	PASS

Note: Refer to next page for plots.

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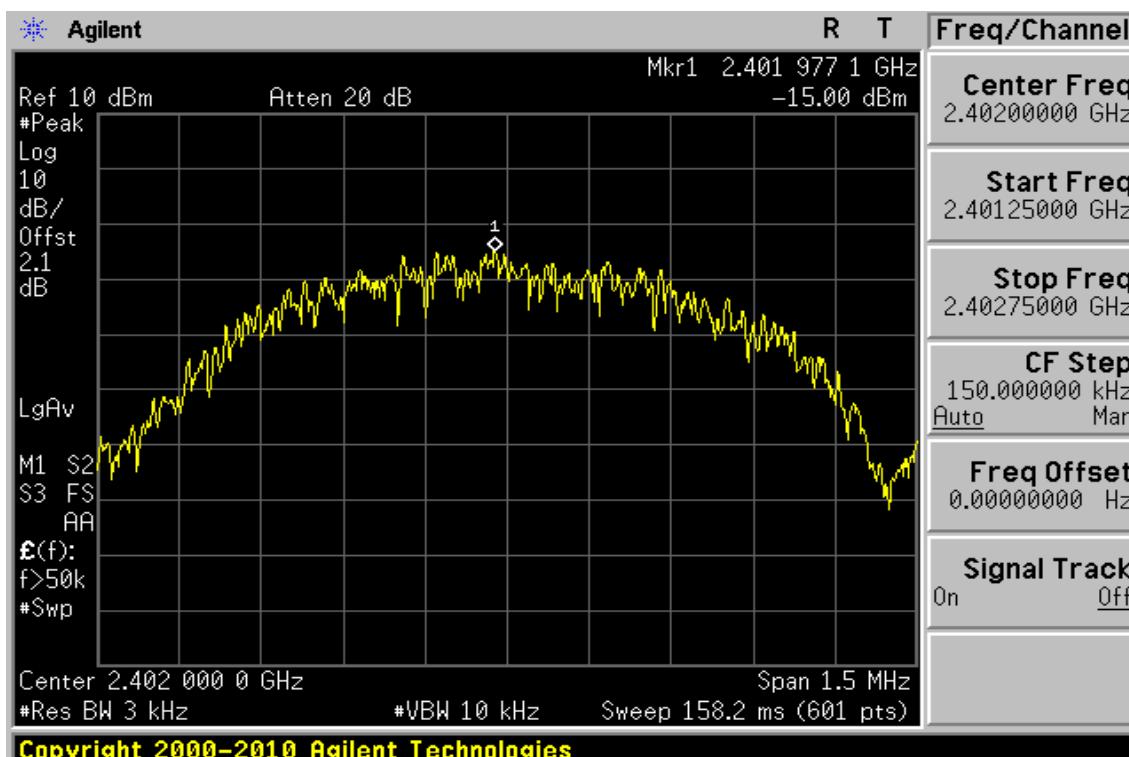
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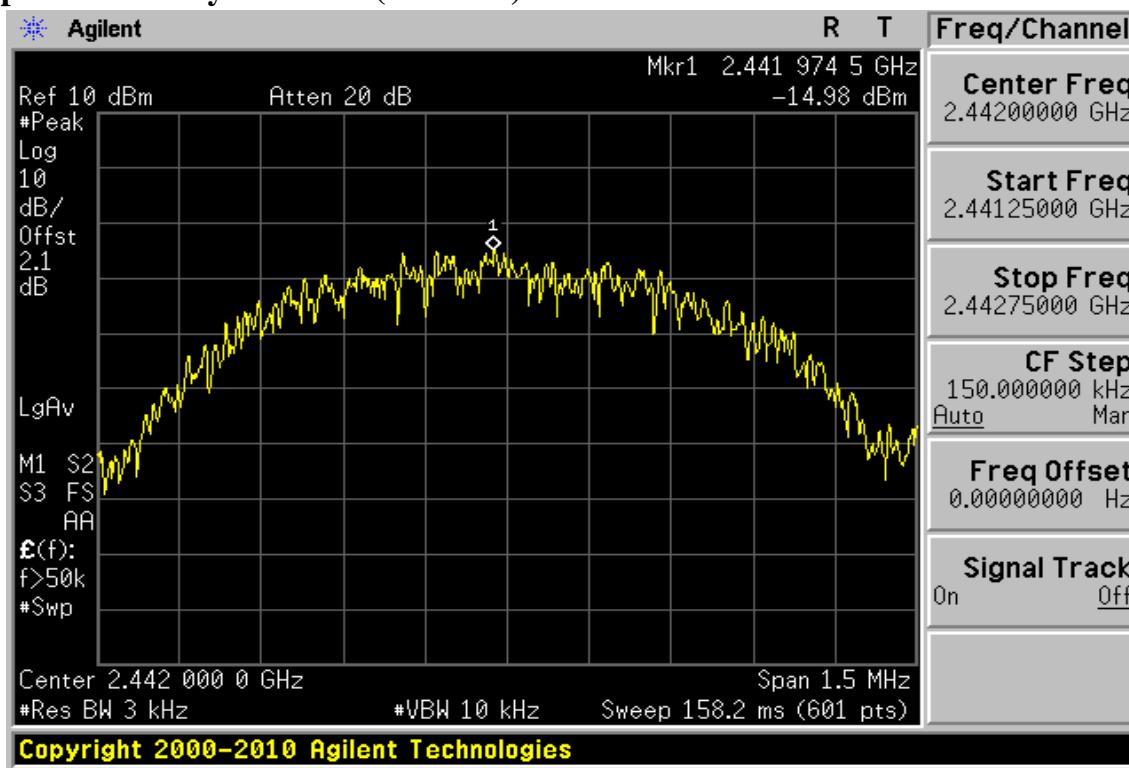
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BT4.0 mode

Power Spectral Density Test Plot (CH-Low)



Power Spectral Density Test Plot (CH-Mid)



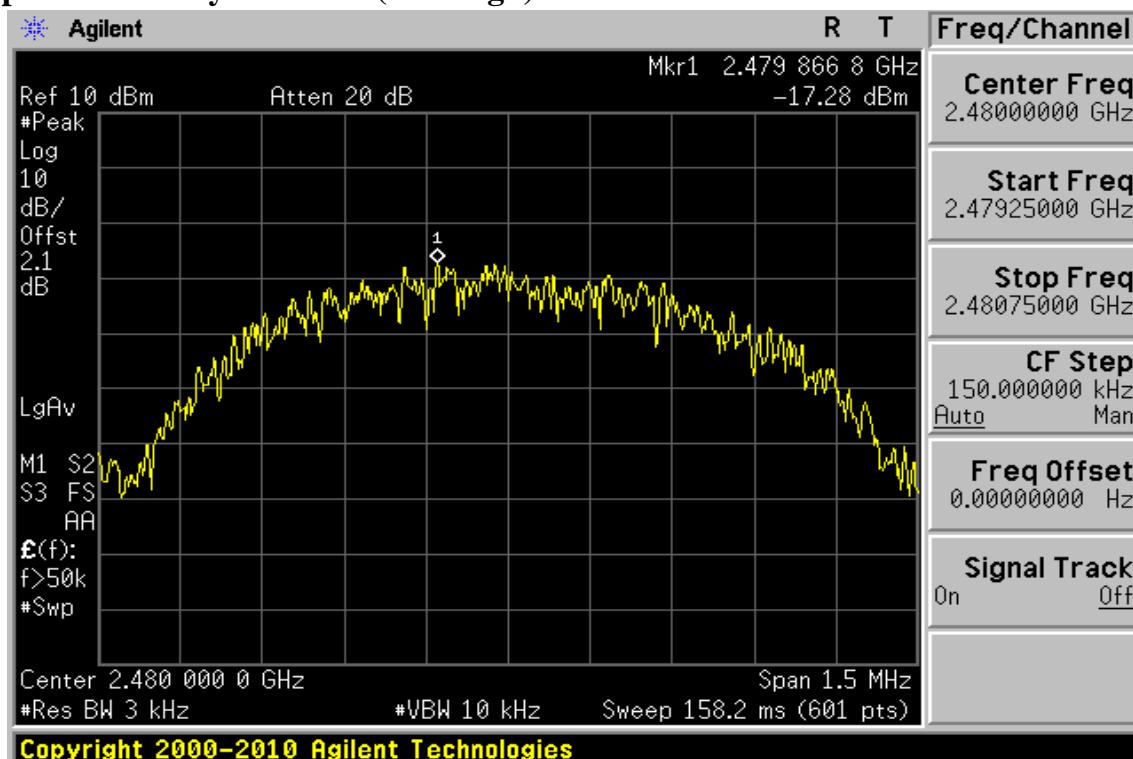
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Power Spectral Density Test Plot (CH-High)



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12 ANTENNA REQUIREMENT

12.1 Standard Applicable:

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

If the transmitting antenna is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi.

In case of point-to-point operation, the power shall be reduced by the one dB for every 3 dB that the directional gain of antenna exceeds 6dBi.

12.2 Antenna Connected Construction:

An embedded-in antenna design is used.

The antenna connector is designed with unique type RF connector and no consideration of replacement.

Please see EUT photo and antenna spec. for details.

The antenna gain is less than 6dBi. Therefore, it is not necessary to reduce maximum output power limit.

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13 MAXIMUM PERMISSIBLE EXPOSURE (MPE)

13.1 Standard Applicable

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

This is a Mobile device, the MPE is required.

According to §1.1310 and §2.1093 RF exposure is calculated.

Limits for Maximum Permissive Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	F/1500	30
1500-15000	/	/	1.0	30

F = frequency in MHz

* = Plane-wave equipment power density

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13.2 Maximum Permissible Exposure (MPE) Evaluation

Frequency (MHz)	Output Power (dBm)	Output Power (W)	Limit (W)
2402	-1.30	0.0007	1
2442	-1.34	0.0007	1
2480	-3.78	0.0004	1

MPE Prediction (BT4.0 Mode)

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = Power density

P = Power input to antenna

G = Power gain of the antenna in the direction of interest relative to an isotropic radiator

R = Distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal:	-1.30	(dBm)
Maximum peak output power at antenna input terminal:	0.74131024	(mW)
Duty cycle:	60	(%)
Maximum Pav :	0.44478614	(mW)
Antenna gain (Maximum):	0.5	(dBi)
Antenna gain (linear):	1.12201845	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2402	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.0000993	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.0000993 mW/cm². This is below the uncontrolled exposure limit of 1 mW/cm² at 2402MHz.

Remark: For RF exposure potentially generating from Co-located transmitter, please reference to the section of collocated MPE analysis, Report No.: ER/2015/20030.

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